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Vascular Complications of Total Abdominal Perfusion and Aortic Stop-Flow Infusion

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During a 2 year period (1992–1993), 149 patients with advanced abdominal cancer underwent total abdominal ischemic perfusion (TAP) and stop-flow infusion (SFI) 159 times in an attempt to achieve palliation. These procedures and aortic stop-flow infusion require insertion of balloon catheters into the abdominal aorta and inferior vena cava by a transfemoral approach. Flow is arrested for 15 minutes, during which time chemotherapeutic agents are infused into the aorta, distal to the balloon occlusion. Femoral access is by a surgical incision. The passage of the catheters is guided by fluoroscopy. Some tumor response was observed in 35% of the patients. Ten patients had major vascular complications; two iliac artery aneurysms were lacerated and required emergency repair. There were two femoral artery false aneurysms that required surgical correction, one early and one late. Aortic dissection was detected in four patients, but these did not require surgical intervention. Two patients had thrombosis distal to the occluded vessel, both required surgical intervention. To reduce the incidence of these vascular complications we recommend: (1) a clinical and vascular laboratory evaluation before the procedure, and (2) angiography of normal flow in patients with underlying vascular disease.

KEY WORDS: **total abdominal perfusion, vascular complications, regional cancer chemotherapy**

INTRODUCTION

The locoregional control of advanced abdominal cancer achieved by systemic chemotherapy is generally poor. Efforts have been made to increase locoregional drug exposure by various regional treatment techniques [1–3]. Total abdominal ischemic perfusion (TAIP) and stop-flow infusion (SFI) were recently described by Aigner [4] for regional chemotherapy of advanced abdominal cancer. The abdominal organs are isolated from the systemic circulation by means of a balloon catheter occluding the abdominal aorta and tourniquets applied to the roots of the lower limbs.

A "stop-flow" situation is thus formed in the abdominal vasculature. An additional catheter can be introduced into the inferior vena cava (IVC) and the abdominal organs perfused by means of an external pump (TAIP). Stagnation and hypoxia enhance the effects of the chemotherapy administered into the system [4].

We have recently summarized our results in a series of 159 SFI and TAIP procedures. We report here the vascular complications associated with the procedure.

MATERIALS AND METHODS

Between December 1991 and February 1995, 149 patients underwent 159 TAIP and SFI procedures. There were 59 females and 90 males, with a mean age of 54 years. The indications for the procedures were mainly for advanced abdominal malignancies of various etiologies (Table I).

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TABLE I. Various Types of Abdominal Malignancies Treated by Total Abdominal Ischemic Perfusion and Stop-Flow Infusion

Colon	50
Pancreas	42
Sarcomas	12
Gynecological/urological	13
Stomach	14
Hepatobiliary	10
Malignant melanoma	8

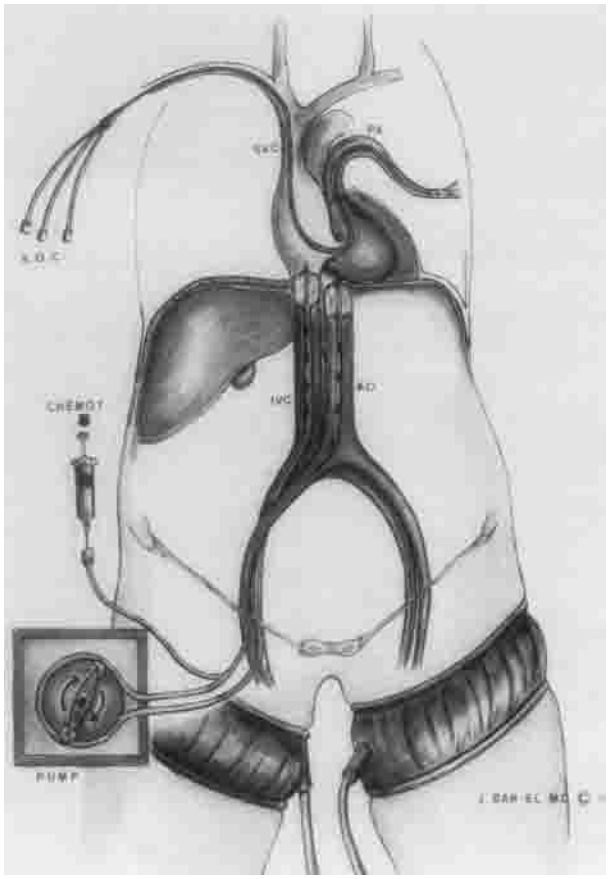

Fig. 1. Schematic drawing of total abdominal perfusion system.

The operative procedure has been described by Aigner [4]. The femoral vessels were exposed in the inguinal region, and no. 8 French (R) arterial and venous double lumen balloon catheters (Produkte für die Medizin, Cologne (Köln), Germany) were then inserted through femoral arteriotomy and venotomy. Their tips were advanced under fluoroscopic guidance to lie superior to the orifices of the celiac artery (aortic) and hepatic veins (IVC) (Fig. 1).

Inflation of the balloon and pneumatic tourniquets, applied previously to the roots of the lower limbs, completed the vascular isolation of the abdominal organs. The catheters were then connected to an extracorporeal pump, and low flow (500 ml/min) hypoxic perfusion commenced for 15 minutes. The chemotherapeutic agents used were injected into the circuit. In SFI, only an aortic catheter was inserted. Once the balloon and tourniquets are inflated, a "stop-flow" situation is established for a duration of 12–14 minutes during which time the drugs are infused.

Various chemotherapeutic combinations were used according to type of pathology, among which the most common were: cisplatinum, 5-fluorouracil, mitomycin C (colon, stomach, hepatobiliary), melphalan, cisplatinum (melanoma), cisplatinum, and adriamycin (sarcoma).

Postoperatively, all patients were followed. Objective response was considered by improvement of biochemical parameters (CBC, liver function tests), or decrease in tumor size as judged by imaging modalities (CT, US, MRI). Subjective response was considered when significant pain relief was reported by the patient and/or downgrading of the Kranofsky criteria.

TABLE II. Summary of Results of Treatment by Total Abdominal Ischemic Perfusion and Stop-Flow Infusion

Complete response	4%
Partial response	12%
Stable disease	19%
Progression	38%
Inadequate follow-up	26%

RESULTS

A total of 149 patients underwent 159 procedures. The objective response rate of the entire group is summarized in Table II.

Subjective response was observed in a significant number of patients. Of the cases with colon and pancreatic cancers, or abdominal sarcoma with severe pain prior to treatment, 80% reported disappearance of pain immediately after the treatment. A significant decrease in consumption of analgesic agents was reported by 8%, whereas 12% had no response to pain relief.

Complications and Mortalities

There were three deaths, all unrelated to the procedure.

Systemic complications of, e.g., atelectasis and urinary tract infections, related to anesthesia and surgery developed in 1% of patients. Chemotherapy-related complications of diarrhea and leukopenia, all of which resolved following appropriate treatment, developed in 1½%. There were 15 (9%) local complications: five patients had prolonged lymphorrhea, and 10 had vascular complications.

Six of the vascular complications (Table III) required surgical repair, whereas the four cases of aortic dissection were followed and did not require surgery. The two cases of perforated iliac artery aneurysm were diagnosed and treated during the procedure. The two cases of acute

TABLE III. Vascular Complications Observed in Total Abdominal Ischemic Perfusion and Stop-Flow Infusion and Their Management

Complication	No. of cases	Management
Perforated iliac artery	2	Repair
Femoral artery false aneurysm	2	Repair
Thrombosis distal to arrested flow	2	Fogarty thrombectomy Femorofemoral graft
Aortic dissection	4	No surgical management (follow-up)

thrombosis were diagnosed and treated during the immediate postoperative period. One case of false aneurysm was diagnosed during the early postoperative period, and the second case was diagnosed 1 month after discharge and treated accordingly. The aortic dissections were diagnosed on routine follow-up CT performed 4–6 weeks after the procedure.

All patients with vascular complications that needed surgical treatment were followed. None of them developed any late vascular sequelae during a follow-up period of up to 30 months.

DISCUSSION

Enhancement of chemotherapy uptake by tumor tissue while minimizing systemic side effects is one of the present major goals of cancer treatment.

Total abdominal ischemic perfusion (TAIP) and stop-flow infusion (SFI) were recently introduced for the treatment of advanced abdominal cancer [4–6].

Isolation of the abdominal vascular segment augments tumor uptake of chemotherapeutic agents administered into the system. The use of rigid double lumen catheters with large distal balloons is mandatory for achieving adequate occlusion of the abdominal aorta and IVC and to prevent catheter migration by the blood flow during the procedure. This may explain some of the vascular complications that developed in our series of patients treated by TAIP and SFI. The accidental iliac artery aneurysm perforations are probably catheter-related. The four cases of aortic dissection might be related to pressure applied by the inflated balloons on a atheromatous area, thus creating an entry point for the dissection.

The rate of catheter-related vascular complications in therapeutic procedures used for cancer treatment as reported in the literature is relatively low [7]. The catheter-related complications rate in our series is 3.7% and may be related to the fact that the catheters used are large and rigid.

The cases of acute thrombosis and false aneurysms are related to the vascular procedure (e.g., arteriorotomy). The rate of these complications as reported in the literature varies with the nature of the procedure [8,9]. In our series, the rate of these complications is 2.5%.

Proper evaluation of the various complications involved in the introduction of new treatment techniques is a main goal of phase-one clinical trials.

These results bring us to the conclusion that in view of the vascular invasive nature of TAIP and SFI and the advanced age of some of the patients, a thorough clinical vascular examination before and after the procedure is mandatory. This examination should screen for underlying problems and other possible risk factors. In selected patients, a vascular laboratory evaluation should be done with a view to supplement results with further imaging (angiography).

This improvement of patient selection and management might decrease the risk of vascular complications in TAIP and SFI.

REFERENCES

1. Aigner KR: Isolated liver perfusion: 5 year results. Reg Cancer Treat 1:111–20, 1988.
2. Lorenz N, Hottenrott C, Baum RP, Liermann D, Enche A: Chemoembolization of hepatic tumors with degradable starch microspheres. In Jakesz R, Rainer H (eds): "Progress in Regional Cancer Treatment." Berlin: Springer-Verlag, 1990, p110–118.
3. Patt YZ, Mavligit GM: Arterial chemotherapy in the management of colorectal cancer—an overview. Seminars in Oncology 18: 478–490, 1991.
4. Aigner KR: Aortic stop-flow infusion and hypoxic abdominal perfusion (HAP) for disseminated bulky peritoneal carcinomatosis: Rationale and technique. Regional Cancer Treatment (suppl 1):3, 1993.
5. Klein ES, Davidson B, Apter S, Azizi E, Ben-Ari GY: Total abdominal perfusion (TAP) in the treatment of abdominal metastatic melanoma. J Surg Oncol 57:134–137, 1994.
6. Klein ES, Berkenstadt H, Ben-Ari GY, et al.: Hemodynamic effects of aortic stopflow and total abdominal ischemic perfusion. Regional Cancer Treatment (accepted, 1994)
7. Myers SI, Harward TRS, Putnam JB, Frazier OH: Vascular trauma as a result of therapeutic procedures for the treatment of malignancy. J Vascular Surg 14(3):314–319, 1991.
8. Adar R, Bass A, Walden R: Iatrogenic complications in surgery. Ann Surg 196:725–729, 1982.
9. Rich NR, Hobson RW, Fedde CW: Vascular trauma secondary to diagnositic and therapeutic procedures. Am J Surg 128:715–721, 1974.